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**Pacific Region**

# Proceedings of the Pacific regional peer review on the stock assessment for the outside population of Yelloweye Rockfish (*Sebastes ruberrimus*) for British Columbia, Canada in 2014

**September 15, 16, and 24, 2015**
**Nanaimo, British Columbia**

**Chairperson and Editor: Kate Rutherford**

Fisheries and Oceans Canada
Science Branch
3190 Hammond Bay Road
Nanaimo, BC V9T 6N7

October 2016

Canada

**Foreword**

The purpose of these Proceedings is to document the activities and key discussions of the meeting. The Proceedings may include research recommendations, uncertainties, and the rationale for decisions made during the meeting. Proceedings may also document when data, analyses or interpretations were reviewed and rejected on scientific grounds, including the reason(s) for rejection. As such, interpretations and opinions presented in this report individually may be factually incorrect or misleading, but are included to record as faithfully as possible what was considered at the meeting. No statements are to be taken as reflecting the conclusions of the meeting unless they are clearly identified as such. Moreover, further review may result in a change of conclusions where additional information was identified as relevant to the topics being considered, but not available in the timeframe of the meeting. In the rare case when there are formal dissenting views, these are also archived as Annexes to the Proceedings.

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## SUMMARY

These Proceedings summarize the relevant discussions and key conclusions that resulted from a Fisheries and Oceans Canada (DFO), Canadian Science Advisory Secretariat (CSAS) Regional Peer Review meeting of September 15, 16, and 24, 2015 at the Pacific Biological Station in Nanaimo, B.C. One working paper focusing on a stock assessment of the outside population of Yelloweye Rockfish for British Columbia, Canada was presented for peer review.

In-person and web-based participation included Fisheries and Oceans Canada (DFO) Science and Fisheries and Aquatic Management Sectors staff; and external participants from First Nations organizations, the commercial and recreational fishing sectors, environmental non-governmental organizations, and academia.

The conclusions and advice resulting from this review will be provided in the form of a Science Advisory Report providing advice from Science to managers and other clients.

The Science Advisory Report and supporting Research Document will be made publicly available on the Canadian Science Advisory Secretariat (CSAS) website.

**Compte rendu de l'examen par les pairs de la région du Pacifique sur l'Évaluation du stock de sébastes aux yeux jaunes (*sebastes reberrimus*) des eaux extérieures de la Colombie-Britannique en 2014**

## SOMMAIRE

Le présent compte rendu résume l'essentiel des discussions et conclusions de la réunion régionale d'examen par des pairs de Pêches et Océans Canada (MPO) et du Secrétariat canadien de consultation scientifique (SCCS) qui s'est tenue les 15, 16 et 24 septembre 2015 à la Station biologique du Pacifique de Nanaimo, en Colombie-Britannique. Un document de travail portant sur l'évaluation de la population de sébastes aux yeux jaunes des eaux extérieures de la Colombie-Britannique, Canada, a été déposé aux fins d'examen par les pairs.

Au nombre des participants en personne ou par conférence Web, il y avait des représentants du Secteur des sciences et du Secteur de la gestion des pêches et de l'aquaculture de Pêches et Océans Canada (MPO) et des participants externes provenant d'organisations des Premières Nations, des secteurs de la pêche commerciale et récréative, des organisations non gouvernementales de l'environnement et des universités.

Les conclusions et les avis qui découlent de cet examen seront présentés sous forme d'un avis scientifique présentant les opinions du Secteur des sciences aux gestionnaires et à d'autres clients.

L'avis scientifique et le document de recherche à l'appui seront rendus publics sur le site Web du Secrétariat canadien de consultation scientifique (SCCS).

## INTRODUCTION

A Fisheries and Oceans Canada (DFO) Canadian Science Advisory Secretariat (CSAS), Regional Peer Review (RPR) meeting was held September 15, 16, and 24, 2015 at the Pacific Biological Station in Nanaimo to review the stock assessment for the Outside population of Yelloweye Rockfish in British Columbia.

The Terms of Reference (TOR) for the science review (Appendix A) were developed in response to a request for advice from the Fisheries Management Branch of DFO. Notifications of the science review and conditions for participation were sent to representatives with relevant expertise from First Nations, commercial and recreational fishing sectors, environmental non-governmental organizations and academia.

The following working paper (WP) was prepared and made available to meeting participants prior to the meeting (working paper abstract provided in Appendix E):

> Stock assessment for the Outside population of Yelloweye Rockfish (*Sebastes ruberrimus*) for British Columbia, Canada in 2014 by K.L. Yamanaka, M.K. McAllister, M.-P. Etienne, A. Edwards, and R. Haigh. (CSAP WP 2013GRF09).

The meeting Chair, Kate Rutherford, welcomed participants, reviewed the role of CSAS in the provision of peer-reviewed advice, and gave a general overview of the CSAS process. The Chair discussed the role of participants, the purpose of the various RPR publications (Science Advisory Report, Proceedings and Research Document), and the definition and process around achieving consensus decisions and advice. Everyone was invited to participate fully in the discussion and to contribute knowledge to the process, with the goal of delivering scientifically defensible conclusions and advice. It was confirmed with participants that all had received copies of the Terms of Reference and working papers.

The Chair, Kate Rutherford, reviewed the Agenda (Appendix C) and the Terms of Reference for the meeting, highlighting the objectives and identifying Dana Haggarty as the Rapporteur for the review. The Chair then reviewed the ground rules and process for exchange, reminding participants that the meeting was a science review and not a consultation. The room was equipped with microphones to allow remote participation by web-based attendees, and in-person attendees were reminded to address comments and questions so they could be heard by those online.

Members were reminded that everyone at the meeting had equal standing as participants and that they were expected to contribute to the review process if they had information or questions relevant to the paper being discussed. In total, 32 people participated in the RPR (Appendix D).

Participants were informed that Kray van Kirk, Dan Tonnes, and Sean Cox had been asked before the meeting to provide detailed written reviews for the working paper to assist everyone attending the peer-review meeting. Participants were provided with copies of the written reviews which are available in Appendices E-G.

The conclusions and advice resulting from this review will be provided in the form of a Science Advisory Report to Fisheries and Aquaculture management to inform fishery planning for the above-noted stocks. The Science Advisory Report and supporting Research Document will be made publicly available on the Canadian Science Advisory Secretariat (CSAS) website.

## REVIEW

| | |
|---|---|
| Working Paper: | Stock assessment for the Outside population of Yelloweye Rockfish (*Sebastes ruberrimus*) for British Columbia, Canada in 2014. CSAP WP 2013GRF09. |
| Authors: | K.L. Yamanaka, M.K. McAllister, M.-P. Etienne, A.M. Edwards, and R. Haigh |
| Reviewers: | Kray van Kirk, Alaska Department of Fish and Game |
| | Dan Tonnes, National Marine Fisheries Service |
| | Sean Cox, Simon Fraser University |
| Chairperson: | Kate Rutherford (DFO, Groundfish) |
| Rapporteur: | Dana Haggarty (DFO, Groundfish) |
| Presenters: | Lynne Yamanaka (DFO, Groundfish) |
| | Murdoch McAllister (University of British Columbia) |
| Meeting: | September 15, 16 and 24, 2015, Seminar Room, Pacific Biological Station, Nanaimo BC |

## PRESENTATION OF WORKING PAPER

Unless otherwise specified, text in non-italic font reflects questions and comments from the participants. Italicised text reflects the responses and comments by the authors. The Yelloweye Rockfish meeting participants (Appendix D) are collectively called "participants" herein.

The lead author started the presentation of the working paper, the Abstract for which appears in Appendix E. Information on distribution, stock structure, life history, the fishery and management histories, the United States fisheries, and the details of the current assessment were provided. The author described the methods used for the reconstruction of historic commercial catches, including workshops with industry, and calculations of annual indices from commercial logbook data. Fishery-independent data were obtained from longline and trawl research surveys that encountered Yelloweye Rockfish. The author also provided biological information on length, age, and age at 50% maturity.

The second author described the Bayesian surplus production model that was chosen for this assessment and outlined the reasons for not conducting an age-structured assessment. The author presented the inputs to the reference case and the results. He provided an explanation of how the Bayesian model updates prior distributions for modelled quantities (priors) and that this is a good diagnostic for model fit. He noted that for most parameters, there is a big update to the priors (page 32) so that it is clear that there is information in the abundance indices to make inference about stock size and parameters. The specific type of prior output inspected (i.e., post-model, pre-data distributions) was a recommendation from Dr. Andy Cooper in the Bocaccio assessment.

The second author presented the specifications for 24 sensitivity runs and their results. The use of a Delay Difference model was one of the sensitivity runs. He highlighted Runs D5 and D6 that were not in the working paper. These additional sensitivity runs, done after the document was written, address comments from the reviews. Run D5 removed the shrimp survey and run D6 included IPHC from 1998-2014 (removal of the first three years). In response to a question, the author confirmed that the "No trawl indices" sensitivity run (D3) did not include the shrimp survey.

The lead author continued with the presentation of the reference points for the reference case, stock projections under various constant catch policies, and a decision table for 5, 10, and 15 year horizons under various constant catch policies.

The lead author concluded with a summary of research needs which included resolving groundfish catch. It was also noted that the need for spatially explicit management and assessment should be considered in the future.

## QUESTIONS & POINTS OF CLARIFICATION

During the presentation several questions were asked to clarify the information being presented. Further discussions on some of the topics are included in the general discussion section of these proceedings.

*In response to a question on how surveys were chosen for inclusion, the lead author responded that surveys were chosen based on the number of years of the survey, the number of years that each survey caught Yelloweye Rockfish, and the number of sets that contained Yelloweye Rockfish. The sablefish trap survey was excluded, even though it had good catches of Yelloweye Rockfish, on advice from industry that the gear was not appropriate.*

Another participant questioned the results of the PHMA south survey. The presentation showed that the last index point was less than half of the previous one; however, the landings data for the surveys indicated that the most recent landings were roughly three quarters of what they were in the previous survey. How reliable is this index?

*The author responded that the index is based on count data, not weight. The authors investigated the discrepancy after the Catch Workshop and made corrections as needed. The Multinomial Exponential Model (MEM) that was applied to the longline records to formulate the index accounts for empty hooks and hook competition; not just nominal catches.*

Another participant asked for a definition of the term "imputed".

*The lead author explained that catch records are not available from the beginning of the time series and that catches were unknown in the early days of the salmon troll and recreational fisheries. The solution was to use fixed-catch scenarios calculated from available effort. Catch records exist for the last 5 years, which can be used as data. Using this modern data, the model calculates a catchability coefficient to derive a probabilistic catch imputation. Catches for both recreational and salmon troll were imputed this way. This method was also tried for the halibut fishery, but the catch rates were implausibly high (Table A.1). Therefore, we chose to "fix" the halibut catches.*

A participant clarified that it was possible to reconstruct effort, but not catch. Therefore, the authors used modern information on effort and catch and made the assumption that modern effort and catches reflect historical information.

Participants asked for more explanation on the new sensitivity runs, D5 (removal of the shrimp survey) and D6 (removal of 1995-1997 from IPHC), and asked the authors to provide a new copy of Table 13 (posterior results summary) to participants that includes runs D5 and D6.

The authors agreed to this.

One of the reviewers noted that most of these columns for the sensitivity results were similar with the exception of *r* (intrinsic growth rate), where the values for the F-series (Bayesian delay-difference model) are 10x the reference case *r*.

*The authors responded that for the F-series the column is mislabeled and for the Delay Difference it is actually the value of the Ricker steepness parameter, h, not the intrinsic rate of*

*increase, r. The author also described some of the differences between the BSP (Bayesian Surplus Production) and DD (Delay-Difference) models.*

A participant asked for clarification on the prior for *K* (carrying capacity) – is it the log of 500-3000?

*The authors responded that there was a typing error and the prior should be 500 to one million tonnes, and should be log (K). This will be corrected in the document and in Figure 21.*

Participants also posed questions on the derivation of the historic commercial catches, the role of RCAs in the assessment, sensitivity runs, differences between the BSP and DD models, and the implicit assumption that selectivity and maturity occur at the same time. These items are covered under their headings in the general discussion section.

## WRITTEN REVIEWS

Unless otherwise specified, text in non-italic font reflects the questions and comments from the reviewer. Italicised text reflects the responses and comments by the authors. The Yelloweye Rockfish meeting participants (Appendix D) are collectively called "participants" herein.

### REVIEWER 1: KRAY VAN KIRK

The review was presented by webinar, accompanied by summary slides. The written review is provided in Appendix B.

The reviewer stated that he did not have much to say with regards to the delay difference model as he did not have expertise on this type of model. However, the introduction to the stock assessment model would benefit with a few sentences outlining the modelling approach and then providing more explanation about differences between the Bayesian surplus production model and the application of the delay difference model to evaluate uncertainties. He pointed out that Appendix G of the working paper was helpful and informative and that more information from the appendix should be in the paper itself.

The reviewer then had questions on Section 2.7.6 (Sensitivity to the type of stock assessment model) of the working paper. This section states that it is "trickier to get non-linear optimization". What does this mean? Did you find a global and not a local minimum? Were parameter bounds set too narrowly? Were there boundary or parameter space problems?

*The second author explained that in setting up some model runs, some diagnostics showed that extra care was required in numerical searchers for the posterior mode. He described steps that were applied to ensure that the software was converging on the posterior modal values. For example, increasing the upper and lower bounds for priors on salmon troll catchability was found to be necessary in some of the estimations to enable the optimization software to search more effectively.*

The reviewer reiterated that it would be valuable to expand on the term "trickier" in the document.

The reviewer questioned the gamma parameter (ratio of halibut landed to rockfish other than POP landed) for the halibut fishery (Appendix table A1, p. 4). The letter from Chris Sporer discusses this and points out the change in Yelloweye Rockfish market value and the consequent increase in targeting and retention on the part of the halibut fleet in the 1997-2005 period. Why were these gamma values altered drastically?

*One of the authors responded that a workshop was held where Science consulted with Industry about the calculated area-specific gamma ratios (ratios of YE to other rockfish). Industry thought*

*these ratios were too high, based on their experience. Science used the Industry ratios but they didn't make a big difference to the catch reconstruction. A sensitivity test was run on these industry-perceived ratios.*

The reviewer asked for this to be clarified in the text and pointed out that he would ask for some pretty drastic statistical evidence before altering a stock assessment like this.

*The author responded that the working group had tried them in sensitivity tests; however, the reconstruction follows closely the actual reported catches.*

The reviewer asked why the calculated release (delta) ratios from trawl were not used and whether it was because there is an assumption that they won't survive release.

*The lead author responded that this was the reason.*

The reviewer asked for clarification on the catches of Yelloweye Rockfish in the salmon troll fishery presented in Table A4 versus the amounts presented in Table A11. In particular, Table A4 does not show any retention of Yelloweye Rockfish by the salmon troll fishery but Table A11 does. Is this the result of imputation?

*The lead author responded that Table A11 reported the imputed catches for the salmon troll fishery.*

The reviewer reported that he uses a similar age-structured stock assessment model for Yelloweye Rockfish in Alaska. The model uses the IPHC survey and he asked about non-normality. The survey is not limited to rocky habitat; it also covers soft habitat so are the data standardized for non-normality?

*The lead author responded that the data don't have to be normal in the MEM model.*

The reviewer also asked if the authors adjusted for habitat sampled, and if extended sets with zero were included.

*The lead author responded no and yes, respectively.*

The reviewer enquired about the source of the age data used to calculate mean weight and age in the DD model.

*The author responded that abundance indices are used in the DD model, which predicts mean body weight given the model assumptions. Mean weights from different fisheries were difficult to obtain as there are fewer observations of body weights than lengths. When both were available they were plotted and there was an almost linear fit. The authors determined that it would be possible to use mean lengths but felt that some sample sizes were small and not representative of the whole coast. A minimum sample size of 200 fish per year was used as an arbitrary cut-off. The mean length was then transformed to mean weight using an allometric function. Both values (weight and length) showed a consistent pattern of decline after 1980. The authors used the relative change in mean weight in the DD model rather than the absolute change. The model was able to make highly consistent predictions of the observed decreases in mean weight and the abundance indices.*

The reviewer then asked whether the authors had estimated the growth parameters using fishery-dependent data.

*The author responded that they fit a von Bertalanffy growth model to the age-length data from surveys.*

The reviewer pointed out that the authors lacked sufficient age data to conduct an age-structured model and asked whether there was enough data for the delay difference model.

*The author responded that if they had wanted to use an age-structured model they could have made similar assumptions to those in the DD model. Sensitivity tests would need to be performed for all the different fisheries, but for most of them there is no catch-at-age data. This would create a huge number of sensitivity tests and require many assumptions about age. The DD model only makes one assumption about the age at recruitment, but it is only one assumption. The DD model is the simplest age-structured model with a minimum number of parameters to estimate. Its estimates of comparable quantities such as stock biomass are not that different from the BSP model.*

The reviewer then had some questions about the length of the time series of catch data. The model begins in 1918 but also explored what would happen if the time series was started in 1951. He wondered whether or not it might make sense to start in the 1970s and asked what is the advantage of the longer time series and what information are contained in the data in terms of signal to noise.

*The author responded that imputed effort is used in the model. There is good evidence that the salmon troll fleet caught Yelloweye Rockfish and that there were recreational catches. This allows for probabilistic assessment of what was there. If the model is started in 1970, it would be necessary to put a wide prior on the starting biomass, and this prior might have big effects on the model.*

*Also, estimates of recent stock size and depletion are less sensitive to where the model starts if you start further back, even when the early catch records inputted are fairly uncertain.*

The reviewer wondered how it would be possible to ascertain if you are getting a signal from data. He concluded that the authors had done a huge amount of work in this involved assessment.

## REVIEWER 2: DAN TONNES

The review was presented by webinar, accompanied by summary slides. The written review is provided in Appendix B.

The reviewer stated that the document was well written and well justified. He mentioned that DFO has a lot of data whereas he deals with less than 10% of the data available to this assessment.

The reviewer asked that the main document elaborate on how historic catch data is derived and used in the assessment, similar to what is in Appendix A of the working paper. He pointed out that they have the same issue in Puget Sound, i.e. they have historic catch data for the rockfish group but don't know how many Yelloweye Rockfish are in the combined group. This species is so rare in Puget Sound now that current data cannot be used to calculate the species split.

*The lead author admitted it was hard to estimate historic catch composition from currently available data given the lower numbers of Yelloweye Rockfish. She agreed that it is an important issue and that the authors will expand the explanation in the document.*

The reviewer said that they will be working on this for Puget Sound and will possibly contact the authors.

*The lead author was open to being consulted and stated that California and Oregon have finished their reconstructions. The second author stated that the reviewer may be interested in looking at the Bocaccio assessment (Stanley et al. 2009). That work involved a few more resources and included interviewing retired commercial salmon trollers to get their recollections of bycatch in different management areas on the BC coast.*

The reviewer then had some comments on future research that could be identified in the working paper. He looked at the US draft recovery plans for rockfish species, including Yelloweye Rockfish, and there are items in those plans that might be worth considering. He agreed with the recommendation about the promise of visual surveys and encouraged the authors to flesh this out a bit more. He noted that the recovery plan also suggests incorporating RCAs and how these may influence recovery. The use of remotely operated vehicles (ROVs) and other non-lethal methods to sample fish will be the direction for assessing Yelloweye Rockfish recovery over time since there are insufficient commercial and recreational data. He thought it would be important to incorporate visual research with how the RCAs are performing. It is also necessary to understand RCA compliance and he surmised that the commercial sector was complying well but there are questions with the recreational sector. It is important to know how we can assess biomass and productivity changes over time.

*The lead author agreed. British Columbia RCAs are in place, some since 2002. There are three years of visual surveys and the documents are being written. However, the future of visual surveys is unknown and the last survey was in 2011; it is not certain that these surveys will continue. There are two components involved: determining fish density and determining habitats coastwide. There is progress on the habitat classification side but the coverage is nowhere near complete for the entire coast.*

The reviewer asked, in a perfect world were funding not an issue, how often would you complete visual surveys?

*The lead author responded that it would be ideal to sample every year but that is not practical; it may be possible to use CPUE data to make decisions about where to survey based on the apparent abundance in the commercial fishery.*

The reviewer noted that the author had identified the need for habitat mapping and suggested that this should be included explicitly as a research need.

*The author agreed that they need this urgently, at a scale that could be used for the density estimates and expansions.*

The reviewer pointed out that Washington state is using genetic information to understand effective population size and this may be something to watch for. It may be more complicated for British Columbia since the northern and southern boundaries are political boundaries, not stock boundaries. He suggested adding this as a potential research item and that perhaps samples were already being collected for this potential analysis in future.

*The lead author responded that DFO has done some genetic sampling to identify the Inside and Outside stocks. They have also done some microsatellite work and researcher, Dr. Ruth Withler, indicates that we can get an estimate of effective spawning size. The letter was read to participants:*

> *From: Withler, Ruth*
>
> *Sent: 2015–September-14 1:12 PM*
>
> *To: Yamanaka, Lynne*
>
> *Subject: RE: Yelloweye effective population size*
>
> *We can estimate the Ne (genetic effective population size) from the microsatellite data. It does give an estimate of the 'effective' number of spawners for a species but will not replace assessment data. The Ne is generally smaller (for some species, much smaller) than the census size of a population and reflects the ability of the population to respond to selection (vs its tendency to lose genetic diversity due to genetic drift). A very small*

*Ne is a sign of a population at risk of losing genetic diversity due to drift alone; but to be useful Ne must be monitored over time and compared with values for larger, abundant populations of the same species.*

*We cou[illegible]stimate Ne values for the yelloweye populations from our microsatellite data, but not by tomorrow! Let me know how the review process goes and we can discuss,*

*Ruth*

*The lead author will follow up with Ruth and will add some information into the document.*

The reviewer suggested that it would be useful to explicitly acknowledge the need for age structure moving forward. The primary data from Washington are visual surveys and it is not clear on how to assess age structure from visual surveys. British Columbia has the advantage of age data from fisheries and it may be helpful to solicit more data from the fisheries. There is also information from Yelloweye Rockfish released from descending devices and there is encouraging information on survivability of descended Yelloweye Rockfish from Alaska. It looks promising that they are surviving after recompression.

*The lead author responded that they are open to cooperative research, including genetic work. DFO has sampled age structured data from the Gulf Islands. In catch from the recreational sector, both retained and released were included, and it was assumed that releases had a 100% mortality rate. She pointed out that descenders are not widely used in British Columbia and this was supported by a participant from the recreational sector. There is no information on what depths the recreational catches are coming from and it is something to explore. She noted that it is good to know that there is some information from the US.*

The reviewer noted that only 3% of anglers reported using descenders in Puget Sound and they have been working with local NGOs to offer descenders to fishing guides (Sequilizer). The reviewer recommended, in terms of research needs, that a social science survey of angler's support for descending devices may be worthwhile.

## REVIEWER 3: SEAN COX

The review was presented in person; the written review is provided in Appendix B.

The reviewer noted that it is a very difficult task to estimate reference points for Yelloweye Rockfish and it puts the assessment scientists in a very tight spot. However, the assessment has been done, TACs have been recommended, and it is now necessary to deal with the results.

The reviewer noted that fishery-independent surveys drive stock assessments and if you don't have them you are left with data-poor methods. Because the surveys drive the assessment it is necessary to be careful about assumptions and fits. It was for this reason that the reviewer requested that the authors drop the first three years (1995-1997) of the IPHC survey; those first years were a trial period and he believed that they are not used in the Halibut assessment. When this was done (sensitivity run D.6) it was possible to see how sensitive the results were to those three data points. He noted changes in some of the parameters and also noted that the biomass changed by 23%. It becomes necessary to decide whether to keep the model results with or without the three index points or to throw them out.

*The authors agreed that there is some sensitivity in the model results to those three index points. The median biomass changed from 3753 to 3936 t, and replacement yield changed from 172 to 151 t (when the three data points were removed (D.4 vs. D.6)). However, these are very small relative differences and they don't affect perceptions about the status of the stock and could be expected to make no difference in the evaluation of management actions.*

The reviewer and author continued their discussion on how various parameters changed in the different sensitivity runs and which of the runs was more sensitive. The reviewer noted that at least one of the parameters had gone to the prior and that this suggests information has been lost and that it is possible that other parameters have also lost information.

*The author explained that some parameters, e.g., the $B_{MSY}$ posterior, are not constrained by the prior. The posterior for r was updated very little from the prior but he did not feel that this was a concern because the prior had been rigorously determined, i.e., it is a credible prior.*

The reviewer said that he would like to see the PMPD update.

*Another author questioned the statement that the IPHC doesn't use the first three years of the survey. He noted that there is a recent report that does give an estimate for those years for the west coast of Vancouver Island.*

The reviewer said this model is fit to historical data but the management decision is based on a forecast. However, he noted that there is no retrospective analysis in the paper and questioned how well this forecasts.

*The second author pointed out that retrospective analysis has been done for other species with this model. He explained that you need to watch for inconsistency between the catch trend and the abundance indices. When the model is making consistent predictions with the index data, there won't be a retrospective pattern. It is possible to do a retrospective analysis. He noted that a model for a similar species in New Zealand reliably predicted the trend seven years into future and an age-structured model was unable to do it.*

The reviewer responded that model behaviour is going to be specific to the fishery so you should do the retrospective model for this if the managers are concerned about this.

The reviewer had questions about the use of the MEM model for adjustments to the PHMA indices and why there was such a drop in the index for the south (Figure C1 in the working paper). He wanted some explanation of how the MEM model was implemented and which numbers were being used in the model.

*The author provided an explanation of Figure C1 which displayed the mean CPUE and the results from the exponential model, which accounts for hook competition, empty hooks and gear saturation. It can account, say, for a lot of dogfish being around one year. The $R^2$ for both are relatively high. Another author added that it was the MEM model results that are used in the stock assessment model.*

The reviewer pointed out that the analysis of the longline CPUE needs to be explained in more detail in the working paper and asked if there was a paper published on the MEM model.

*The author answered that Marie Etienne is working on the paper which has been semi accepted and an earlier version has been published.*

The reviewer questioned why you would use an unpublished method.

*The author responded that Marie Etienne was thorough in her analysis. She simulated loss of bait, compared bias in trends from longline gear if you used CPUE vs the exponential and the estimates of trends were far more accurate with the exponential model. The author noted that he could send a draft of the paper. She has a simulation for mean densities of fish over time. It's very convincing.*

The CSAP participant noted out that if the participants have not been provided with the reference and it isn't published, it becomes a challenge for the room.

The reviewer also pointed out that there is some text in the document that the Bayesian surplus production model has been tested but this has not been referenced.

*The author responded that MEM has been applied in two previous assessments, Inside Yelloweye Rockfish and Quillback Rockfish and in addition the IPHC has applied it.*

The reviewer moved on and stated that a big question is the spatial structure of Yelloweye Rockfish. Previous assessments have been strongly stated that it makes the assessment difficult, but this one takes a coast-wide approach. He asked if the authors wanted to add something to the paper or comment now.

*The lead author stated that spatial structure has been an issue all along. In the first assessment in 1992, an assessment was done by statistical area (30 distinct areas) but managers couldn't manage by those areas. Science was asked for grouped quotas over 5 management regions (QCI, NC, CC, WCVI and SG) coastwide. In 2001, she detailed how they assessed fishing mortality (F) on the outside using catch curves and reduced catch by 50% in direct proportion to F to satisfy an $F_{opt} \leq 0.5$ M policy recommended by the US SSC in 2000. At the same time, Science recommended rockfish conservation areas (RCAs) to protect a portion of the stock from harvest, accounting for all catch and increasing stock monitoring. Another paper exploring harvest policy in light of RCAs introduced the idea of maintaining zero F within RCAs and higher F's outside in the open fishing areas whereby in aggregate, the combined overall F (inside RCAs + outside RCAs) did not exceed $F_{opt}$. This would acknowledge that some open areas would be overfished but this would be offset by F=0 within RCAs. That paper wasn't published by CSAS. The rockfish conservation strategy reduced quotas by 50% and put aside 15% of area in RCAs. Management policy has been that we don't look at the RCAs, i.e., we don't survey them in research surveys. In 2006, the CIC requested that the quotas over the 5 management regions be reallocated into the trawl management areas because the trawl areas were to be used for quota allocations under the new Groundfish Integrated Fishery. There wasn't enough data to be able to put spatial structure into this current assessment.*

Another reviewer asked if latitude and longitude were available for commercial catch data.

*The lead author responded that from 2002 onward there are credible latitudes and longitudes, but before then most of the logbook spatial data are not useable.*

*The second author commented that spatial structure is important. He noted that you can get a lot of bias without considering spatial structure and movement is the most important consideration. However, Yelloweye Rockfish are relatively sedentary. With the RCA closures effort is redistributed to outside and the assessment would track the portion of the stock in the outside areas. Fish in the RCAs are still providing recruits; however, there is some belief that recreational fishers don't necessarily comply with the closures. The authors made the simple assumption that biomass hasn't changed in the 15% of the coast that is closed to fishing.*

An industry participant stated that it sounds like there is no benefit to the RCAs.

A participant clarified with information on surveys that were conducted in RCAs. Approximately 35 RCAs on the south coast, some in the inside waters and some on the west coast of Vancouver Island, were surveyed with an ROV when the RCAs had been in effect for between 3 and 7 years; this is a short time period with respect to the life history of Yelloweye Rockfish. The surveys were not able to detect any difference in the density of Yelloweye Rockfish inside and outside the RCAs, so it is justifiable for the author's calculation to assume constant biomass to date. This may not be the case in the future since we expect biomass in the RCAs to increase.

Another participant stated that RCAs are not completely unfished as FSC fishing is allowed within RCAs.

The reviewer noted that he was under the impression that RCAs were much more widespread. He would like to see an addition to research needs in terms of issues with regard to visual surveys because of detectability.

*The author responded that avoidance is a main issue and they will add this need to the document.*

The reviewer noted that because the ROV survey is visual, the biomass estimates are not absolute.

*The lead author agreed and said that SE Alaska does use visual density estimates that are expanded to estimate biomass over the available habitat. This is also done for the Cowcod (Sebastes levis) assessment in California.*

The reviewer thought this was a good point and if you did that expansion it could be a feasible way to manage the fishery. He suggested asking Alaska about costs and include that for future research as cost will be important.

Another reviewer agreed that cost is an important factor for visual surveys. He also noted that variances are huge with visual surveys and they don't include variance of habitat which is also huge.

The reviewer then asked how managers are supposed to manage across the provided decision tables.

*The author responded that the approach is to evaluate the sensitivity of the results. This can be done by calculating Bayes factors which provide guidance on selecting one model over another. Bayes theorem describes the posterior probability of a model given the data. A Bayes factor compares the posterior probabilities from two models given the same data. He gave the example of comparing two scenarios (low catch vs. high catch) where the low-catch scenario is 20% more realistic, given the data. However, the base case (intermediate catch) cannot be rejected because the Bayes factor for the base case is not low enough to lead to its rejection. When Bayes factors indicate that different scenarios are credible, the different scenarios can indicate how far wrong you can be.*

The CSAP representative reiterated that it is the job of this process to provide advice to managers. At the end of the meeting, we have to provide advice based on the assessment.

The reviewer pointed out that there were two decision tables based on sensitivity tables and asked about the other sensitivity runs.

*The author answered that the evaluation of hypotheses is based on what is going to have the widest range of consequences. The different catch scenarios are also going to have a big influence on projection results. The scenarios covered the extremes in replacement yield. A decision table has to have hypothesis, policies, and probabilities.*

The reviewer summarized that these decision tables were chosen based on the extremes of the outcomes. He then asked about fixing the error variances for all of the data sets.

*The author explained that they went through iterative re-weighting until they got credible CVs. The actual CVs are fit in an iterative way in a function minimization with a lower bound of about 15%. For example, the Shrimp survey CV was 0.6.*

The reviewer requested that it should be noted in the document that observation error variance was being estimated and also clarify what the final observation errors are.

The reviewer then moved on to ask about the use of the IPHC survey. There was some confusion on whether just the surveys north of Vancouver Island were used or the entire coast.

*The lead author explained that for some years the whole coast was available and for others just the northern area. However, the authors used all available data. In Appendix B, all series were explored and the trends were the same. All data were used in the MEM analysis; trends are the same for all areas.*

The reviewer noted that the text for Figure B13 is incorrect. He commented that if 80% of the stations are in the north, when you look at north compared to south, it will look a lot like the north. He suggested that a comparison of north to south was needed and that it could be backed up with a power analysis because data are noisy.

The reviewer noted that most of the data are counts, and this is a biomass model. There is a plot showing mean weights changing.

*The second author responded that the mean weight computed from commercial longline landings of Yelloweye Rockfish show very little change from 1996-2002, the period that they overlap with the IHPC survey.*

The reviewer asked whether an index of numbers or biomass was input into the Bayesian surplus production model.

The author *answered that biomass was input, as well as mean body size, as predicted by the delay difference model. It is stable from 2000 onwards.*

The reviewer noted that the authors did not provide advice for the future assessment schedule.

*The lead author replied that they had missed that requirement in the terms of reference. There will be a reassessment for COSEWIC in 2018.*

The reviewer asked if the age composition plots were pooled total samples.

*The author responded that the ages were from the two longline surveys.*

The reviewer wrapped up by noting that it would be useful to split the samples out by individual survey so they can be used to track cohorts.

## GENERAL DISCUSSION

During the course of the RPR meeting there were discussions on a number of topics related to the presentation of the paper and advice. For this proceedings document, discussion has been grouped by topic area, rather than chronologically. There is also a separate section that covers the reconvened meeting of September 24, 2015.

### CATCH

Over the course of the meeting there were extensive discussions on the catch data that were presented in the working paper. In particular, questions arose on the commercial catch reconstruction and the imputation of salmon troll, and recreational catches.

The primary concern appeared to be the impact the catch amounts and their associated errors would have on the calculation of the initial unexploited biomass ($B_0$). The sensitivity runs in the model were meant to bracket the uncertainties but there was general discomfort with the catch data, particularly the catch imputed from effort.

The authors provided an explanation of how the model imputed catch and how it accounts for uncertainty internally; this is a rigorous feature of the model used.

The general discomfort of the imputed catches was having them published (Table A11) and being carried forward as real catch amounts as opposed to outputs of the model. It was agreed

that the table caption and text would be modified to clearly identify that these are not the official record of catch.

Particular issues of the various sources of catch data are noted below.

### Recreational catch

A question arose on the extrapolation of the west coast Vancouver Island (WCVI) creel and Central Coast (CC) lodge/guide data to the entire outside coast using the iRec (internet recreational effort and catch survey) data.

*The authors responded that they would like to have used the results of the iRec survey as the information is available for the entire coast. However, because the iRec information was still preliminary they were only able to use it to roughly compare the proportion that the WCVI and CC creel data accounted for. These preliminary results showed that, compared to iRec, the WCVI and CC accounted for 56% of the total Yelloweye Rockfish catch so the authors used 50% as an estimate: Total outside YE = (WCVI + CC)*2. These results are reported in Table A7.*

A participant asked whether the average fish weight was from observed or measured weights and commented that if the stock was overfished it would be expected that the average weight would decrease. The participant also asked whether the same average weight was used for releases as for kept fish.

*The authors responded that the average weights were from surveys as there is no monitoring of the recreational fishery. There is no way of knowing if average weight is decreasing in the recreational fishery.*

As noted above there were concerns with the imputed recreational catches being published (Table A11). Participants agreed that modifications should be made to the text and table to clearly identify that these are not the official catch records but are model outputs.

There was some general discomfort about the recreational catch numbers that were being used in the model. In particular, the catches in the mid-1980s to 1990s seemed very high.

*The authors responded that they attempted to bracket the uncertainty by halving and doubling the catches in the sensitivity runs. They noted that relative to total removals the recreational catch is small. The calculation of the recreational catches is very sensitive to the effort.*

There was a lengthy discussion on a credible history for the recreational fishery with additional sensitivity runs being suggested: no effort prior to 1975 and ramp up the effort from 1975 to 2002.

### FSC catch

It was suggested that FSC catches be separated from commercial fishing and be flagged as an "incomplete estimate". When FSC landings are combined with commercial trips, it is recorded in the Fishery Operations System (FOS). However, only a portion of FSC is landed in commercial trips. There is a gap in solely FSC (not combined with commercial trips) reporting.

### Commercial catch (groundfish fisheries)

It was noted that the biggest impact on the model is the catches of Yelloweye Rockfish in the 1980s. There were some concerns from participants over the reconstruction for 1991 to 2005, primarily on the estimation of parameters (beta and gamma) to convert aggregated landings data to species catch weights. Concerns were voiced by industry participants at two data workshops, held during the spring, to resolve some of the uncertainties in the catch

reconstruction. Two letters sent by the PHMA to DFO regarding the catch reconstruction are included in Appendix A of the assessment document.

A participant noted that historic catch data prior to 1951 are very different than those post 1951. Products were converted to green landed weight (i.e. estimated) and catch species composition was also unknown. He asked if the authors had looked at only doubling the data prior to 1951 in their sensitivity analyses.

*The author replied that prior to 1980, the catch is very low. In the sensitivity runs the catches were halved and doubled but due to the low catches prior to 1951 they did not think just doubling or halving the catch data prior to 1951 would make a big difference. However, this was not tested.*

The participant suggested that it might make a difference and that authors may want to try dropping all catch prior to 1951, particularly for District 1.

Another participant noted that the most recent Lingcod stock assessment deals with District 1 and does include it.

### Salmon troll

There were concerns from the participants on how the estimates of Yelloweye Rockfish catches from the salmon troll fishery were derived and that the document needs to be more explicit.

*The authors explained that there was a back calculation of effort (similar to that for recreational fishing) and that the catch per unit effort relationship from recent years was applied to earlier years. In years when there was more effort on salmon, there would be more YE caught.*

An industry participant asked whether the method was the same as that used in the Bocaccio assessment and sought clarification on whether only effort directed at Chinook Salmon was included. Several participants stated that one would only catch Yelloweye Rockfish if one were trolling for chinook, not other salmon species.

It was pointed out that it is not possible to figure out which species of salmon was targeted from the electronic data available.

An industry participant commented that salmon troll landings up to 50 t in the 1980s is extremely high. It was also asked if the landings had already been included in commercial landings.

*The authors replied that when they reconstructed commercial catches, troll gear was not included so they feel that it was not double counted.*

There was a further comment on how commercial catch data were recorded prior to 1951 (see comments under commercial catch – groundfish fisheries) so they may have been included in the commercial catch.

*The authors noted that they will follow up on this issue.*

Similar to the presentation of imputed recreational catches, there was concern about having the imputed salmon troll catches published (Table A11).

The chair reminded participants that salmon troll imputed numbers would be clarified as model outputs (same as for imputed recreational catches).

In order to bracket the uncertainty of the salmon troll catches of Yelloweye Rockfish additional sensitivity runs were recommended: use one-quarter of the entire salmon catch series values, and remove all salmon troll catches prior to 1950.

## SURVEY INDICES

The model results were influenced by trends in the indices. There was a question about whether the various survey indices were weighted.

*The authors responded that indices with low CVs were given more weight by default.*

Participants questioned how appropriate surveys other than the PHMA survey were to assess Yelloweye Rockfish as the PHMA survey is the only one designed for rockfish.

The *authors clarified that the surveys are being used as indices of abundance. If the survey is conducted in the same way year after year and you sample the same way, you get an index of abundance that can be used.*

Participants noted that if RCAs are not surveyed and they are trending differently than outside you might get biased results.

There was also a question on what survey catches would have to be to get the stock into the healthy zone.

*The authors responded that the maximum increase (in the absence of fishing) would be 4% per year so after 5 years it should be detectable (15-20% increase).*

Participants also brought up the issue of whether combining PHMA North and South may be masking increases (or decreases) in the areas separately. It was also asked for confirmation on whether the MEM analysis methodology had been peer-reviewed.

*The authors responded that the PHMA North and South surveys remain separate series in the assessment and that the MEM analyses had been reviewed.*

Additional sensitivity runs were requested using unadjusted PHMA data for North and South, separately.

## COMMERCIAL FISHERY INDICES

There were questions from industry participants about the use of fishery indices when previous assessments state that logbook data cannot be used for indexing abundance.

*The authors described the GLM analysis of the logbook data which examined and removed the effect of factors such as fleet, depth, and time period.*

A participant noted that CPUE is affected by the behaviour of fishers, for example, trying to avoid Yelloweye Rockfish.

*The authors responded that the fishery indices are showing the same decline as fishery-independent indices. This was tested by removing the logbook indices in sensitivity run D2.*

## MODEL CHOICE

In an effort to determine what is driving the model a participant pointed out that the model results seemed to hang on the prior for *r* and the IPHC index which he said showed a one-way trip.

*The author pointed out that the results also hinged on the indices which are not classical one-way trips as they show a decrease and then flatten out. It was also pointed out that it is necessary to look at the diagnostics of the model and one of these diagnostics is internal consistency in fitting the model to the data. The BSP model is fitting the data and the post-model pre-data distributions (PMPD) were updated by the data. It was not expected that r would be updated because it is well established with life history information.*

There was some discussion on the differences between the Bayesian Surplus Production (BSP) model and the Delay Difference (DD) model.

*The authors support the use of the BSP model – it is making predictions of surplus production based on the previous year's stock biomass and catch removal. The DD model is making predictions based on recruitment 15 years earlier.*

There was also a lot of concern about the concept of $B_0$ and the goals of needing to rebuild to an unrealistic value (COSEWIC, SARA).

*The authors responded that with the BSP, carrying capacity K and intrinsic rate of growth r are estimated to yield the best estimate of $B_0$.*

There was still some concern that the prior on *r* is too tight and consequently constrains the model from achieving higher $B_0$.

The question of selectivity arose for both the BSP and DD models. The models assume the age at 50% maturity is knife-edge at 15 years and the same as selectivity.

*The authors responded that the age at 50% maturity came from surveys. This value is one of the key assumptions to the DD model. The model predicts the surplus given the catch and abundance indices. The actual age is not that important but it would not be good if the fishery and survey vulnerabilities were very different.*

Participants had concerns with potential differences in maturity at age and selectivity at age having impacts on $B_{MSY}$.

*The authors responded that slight differences were not a large issue for the BSP model and can be tested by simulations.*

It was requested that the authors include a fuller discussion in the working paper on these impacts and provide citations for the simulation testing.

There was general acceptance that the BSP model was a reasonable approach. It has been used for past assessments (Bocaccio, Inside Yelloweye Rockfish, Coastwide Quillback Rockfish and Outside Lingcod). The bigger concerns are the inputs to the model. There were concerns that changes in the fisheries since 2002 are not being properly represented. The fisheries have been avoiding Yelloweye Rockfish in recent years and hence abundance indices derived from fishery data are trending down. These downward trends do not reflect what fishers experience on the grounds; Yelloweye Rockfish are difficult to avoid.

## REFERENCE CASE

The authors presented the reference case as the choice for providing advice; it uses all the indices and all the catches. However, many participants questioned this choice given the discussions on catch histories, choice of *r*, etc., and requested more rationale as to why the reference case was more credible than the other scenarios.

There was also a question as to why a model-averaging approach was not taken.

*The authors responded that in a model-averaging approach the various scenarios would have to be weighted to account for certainty.*

## SENSITIVITY RUNS

Initially, the authors conducted 22 sensitivity runs as a way of capturing the uncertainty in the inputs, e.g., historical catch, priors, abundance indices.

There was extensive discussion on the DD model. However, it was used as a sensitivity test and not for advice and the authors did not run a lot of sensitivities on it. There was also a question on why steepness was updated so markedly when *r* wasn't.

*The authors responded that the stock is not seeing recovery despite lowered catches since the 1990s so steepness has to go down.*

It was pointed out that there has been a possible decline in catches (so a decline in the CPUE index) due to avoidance stemming from markets and management changes. It was asked whether this could be feeding the results.

After lengthy discussions on the model inputs the decision was made for the authors to conduct additional sensitivity runs adjusting the salmon troll and recreational catch amounts.

## REFERENCE POINTS

Reference points were provided in a decision table. It was requested that the authors add 0.4 $B_{MSY}$.

The additional sensitivity runs requested at the end of day 2 will inform the advice. The reference case will be revisited if the new sensitivities show differences.

## SPATIAL STRUCTURE

There were concerns, particularly from industry participants, that the model and resulting outputs should have been conducted on a smaller spatial scale. They observed that there are distinct spatial differences in abundance, e.g., between the west coast of Haida Gwaii and the west coast of Vancouver Island.

*The authors responded that there was enough data to support a coastwide assessment but not by smaller spatial areas. Setting area-specific total allowable catches (TACs) is an allocation issue for managers. There will need to be investigation into how to gain a more spatial perspective and the continuation of fishery-independent surveys is needed to inform the assessment process. If changes are seen in different areas as the surveys continue, that information can be used.*

Industry participants noted that there are untouched pockets of Yelloweye Rockfish but because this assessment is for the entire coast, it appears that the stock is going down.

*It was noted that it will be important to capture the need for future work that looks at methods to examine the data spatially.*

There was also discussion on the RCAs and whether this coastwide assessment accounts for the 15% of habitat in RCAs.

The role of rockfish conservation areas (RCAs) as refugia, as well as additional refugia resulting from economics (e.g., areas too far away for harvesting to be financially viable) was discussed. Research surveys do cover areas that might be considered as economic refugia. There was also discussion on the contribution of RCAs to the coastwide stock (see indices discussion).

## TIMING OF REASSESSMENT

There was discussion on timelines for the reassessment or Yelloweye Rockfish. This requirement was missed in the working paper.

*The lead author noted that Yelloweye Rockfish was scheduled for reassessment by COSEWIC in 2018.*

Participants pointed out that COSEWIC would not necessarily be the reason for a reassessment; other factors will have an impact. There was discussion on appropriate reassessment timing, e.g., when more data have been collected or when a significant change in population is expected (might expect to see something in 5 years but that is speculation). Reassessment in 5-10 years was suggested. Another participant countered with two years but it was pointed out that Yelloweye Rockfish are long-lived and slow growing so reassessment that soon would not be useful unless new methods are developed.

A management participant asked the purpose of setting an assessment interval and the CSAP participant responded that it is necessary so reassessment is not ignored.

It was suggested that an upper bound of 10 years be set for reassessment, with the recognition that there is interest in exploring spatial tools, which could trigger reassessment sooner. It was also recommended that there be regular monitoring of survey data.

## PROVISIONAL ACCEPTANCE OF WORKING PAPER

At the end of the 2-day meeting the majority of participants provisionally accepted the working paper with edits and agreement to conduct additional sensitivity runs. A participant from the Canadian Sablefish Association indicated that they did not support the paper due to concerns regarding the inputs to the model and the spatial scale of the assessment.

It was agreed to reconvene the RPR to discuss the new results.

## RECONVENING OF RPR

The RPR was reconvened on September 24, 2015. The purpose of the meeting was to examine additional sensitivities and language for the SAR (Science Advisory Report). Prior to the meeting a number of documents were distributed. Participants were advised that the group would be crafting advisory advice bullets, language around uncertainty, and experts would look at language around the model.

Participants were asked to examine whether the new sensitivities led them to have different conclusions from those from the first two days of the RPR meeting re: the reference case not being the best. The complete list of model runs, including new sensitivities includes:

*Table 1. Complete list of model runs.*

| Code | Category Description | Code | Run Description |
|---|---|---|---|
| Ref | Reference run | Ref | BSP($\varphi$=0.5) reference run with $\sigma_p$ = 0.05 |
| A | Catch scenarios BSP ($\varphi$=0.5). | A.1 | Using troll and recreational catch values from posterior medians in base case run as fixed values and not fitting the model to the recreational catch data obtained in recent years, all catches treated as fixed+known |
| | | A.2 | Halibut catch series obtained from bycatch ratio estimate in recent years |
| | | A.3 | Halibut catches imputed using halibut effort data and an estimate of halibut bycatch q |
| | | A.4 | Catches before 2006 (catch inputs including combined, rec. and troll) set at 0.5 of base case |
| | | A.5 | Catches before 2006 (catch inputs including combined, rec. and troll) set at 2x base case |
| | | A.6 | PHMA catch series |
| | | A.7 | Adjusting rec effort - zero effort prior to 1975, rec. effort ramping up exponentially to 2002 |

| Code | Category Description | Code | Run Description |
|---|---|---|---|
| | | A.8 | Removal of salmon troll catch prior to 1950, and use ¼ of salmon troll catch data values |
| | | A.9 | Implementing both A.7 and A.8 together |
| | | A.10 | Starting the BSP model in 1951 (not in 1918), otherwise the same as the reference case |
| B | Priors | B.1 | prior mean r set at 2/3 base case |
| | | B.2 | prior mean r set at 1 1/3 of base case |
| | | B.3 | uniform on K prior rather than uniform on logK prior |
| C | Process error standard deviation | C.1 | $s_p$ = 0.025, (close to SD in process error in stock biomass from BDD model with sigmar = 0.5) |
| | | C.2 | $s_p$ = 0.075, (~2 x SD in process error in stock biomass from the BDD model with sigmar=0.8) |
| D | Abundance index data | D.1 | no IPHC index, but including the rest |
| | | D.2 | no FOS and no PHL index, but including the rest (no logbook-based indices) |
| | | D.3 | no trawl indices, but including the rest |
| | | D.4 | only with IPHC and PHMA index |
| | | D.5 | Leaving out the Queen Charlotte Sound shrimp trawl index, otherwise same as reference case |
| | | D.6 | only with IPHC and PHMA index but with IPHC starting in 1998 (removing 1995-1997 IPHC data) |
| | | D.7 | only with unadjusted PHMA south index |
| | | D.8 | only with unadjusted PHMA north index |
| | | D.9 | only with unadjusted PHMA south and north indices |
| E | Generalized surplus production model | E.1 | Bmsy/K set at 0.3 |
| | | E.2 | Bmsy/K set at 0.4 |
| | | E.3 | Bmsy/K set at 0.6 |
| F | Bayesian delay-difference model | F.1 | sigma R set at 0.5, fitted to same data as BSP |
| | | F.2 | sigma R set at 0.8, fitted to same data as BSP |
| | | F.3 | sigma R set at 0.5, fitted to same data as BSP and also mean commercial longline length data 1986-2002, CV=0.3 |
| | | F.4 | sigma R set at 0.5, fitted to same data as BSP and also mean commercial longline length data 1986-2002, CV=0.15 |

The lead author presented the additional sensitivity runs. The new sensitivity runs agreed to from the September 24 meeting were A7, A8, A9, A10, D7, D8, and D9.

The author noted that the outputs of A7, A8, and A9 were very similar to the reference case and noted that the PHMA survey series (runs D7, D8, D9) was too short to inform the stock assessment model. The model results were very close to priors and examining the PMPD, it would not be valid to take seriously.

The author described that for the reference case the ratio of variance for Posterior/PMPD was 0.11, suggesting a good model update. In the least informative cases the variance is very spread out and considerable probability is in the tails.

A participant did not recall that the new sensitivity runs were to look at only the PHMA unadjusted and it is not possible to tease out differences from previous runs with adjusted

PHMA. An industry participant asked for confirmation that the PHMA data were contributing information to the assessment.

The authors responded that the PHMA surveys add to the information but are not enough by themselves to produce informative posterior results.

In regards to the ratio of variance, a participant asked if there was guidance on reasonable rates and whether there is reference that could be cited. The authors responded that ratios >= 1 mean no update; >0.5 update is not very informative; 0.10 update is substantial. He noted that you can also look at the coefficient of variation. There is no definitive reference but there are a lot of papers on the ratio of Posterior to Prior; PMPD is used when there are no priors.

A participant asked whether there was any ratio of variance for the probability of being above the critical zone statistic, i.e., $P(B_{CUR}>0.4B_{MSY})$.

The authors provided an explanation of $B_{MSY}/K$ ratio. The results of the Delay Difference model leads one to think run E1 where the ratio was set at 0.3 is not likely.

A participant responded that at the meeting previously there was discussion on the fixed selectivity function assumption, i.e., a strong assumption of spawning at age 15 and not so much information for recruitment to the fishery. She felt that the Delay Difference model was not explored enough to use as a rationale for the $B_{MSY}/K$ ratio.

The consensus was that the Delay Difference model was accepted as a sensitivity but was not enough to inform the BSP and had not been explored enough to provide advice.

The authors continued with presentation of the IPHC abundance series and noted that they will update the document with a better description. The nominal (unadjusted) index would show less of a decline if WCVI was not used. The MEM takes things into consideration (e.g., empty hooks) so it is difficult to compare with nominal (unadjusted) index.

For run D6 the values for 1995-1997 dropped but WCVI is still included and the results are more pessimistic.

Another author reiterated that the treatment of the IPHC data was not explained very well in the document. He confirmed that MEM was used in the model and that all the data (north and south) was used. This addressed the concern by one of the reviewers that only north had been used. There was some discussion on adjustment factors between MEM and unadjusted but this had not been examined to see what it would mean to the model.

The lead author continued with presenting the results of the new sensitivities and concluded that there were no other runs that changed the perception of stock status. It was noted that, at best, there is a 43% chance that the stock is larger than 40% of MSY. The authors felt that there was no alternative scenario to replace the reference case as the best advice.

When asked by a participant to explain why the reference case is "best", the authors explained that the sensitivities were used to examine catch, etc. but nothing changes the trajectory and the stock is still in a bad place.

There was discussion on the use of sensitivity runs to test the reference case and the factors that would cause the reference case to be rejected. The authors did not feel there was enough information to reject the reference case and noted that they would not support a model averaging approach.

A participant noted that he was not necessarily objecting to the process of choosing the reference case but felt that there are lots of questions and the rationale is not well explained on the choice of data and inputs for the reference case. Whatever case is chosen for the reference

case wouldn't see much difference in results but the differences in catch are quite different from the existing TACs, therefore the implementation of these cut backs will be difficult.

An industry participant objected to the authors stating that the new runs were overly optimistic. He had spoken to many people about the behaviour of Yelloweye Rockfish and viewed the results as realistic. From his perspective, the model is not good and the troll catch series is too high.

A discussion on the use of commercial CPUE data followed; industry participants noted that CPUE will continue to decline due to factors such as avoidance and that they don't like the coastwide approach.

It was also pointed out to participants that it is necessary to use objective criteria for choosing a case, not selecting the case based on the results.

A management participant summarized the discussion:

1. Catch scenarios – A9 is a closer reflection of what is plausible.
2. PHMA surveys have the most viability but the time series is too short so don't use them alone.
3. Catch CPUE should not be used.
4. A9 and D2 should be combined.
5. Concerns regarding coastwide vs. spatial – affirmed that concern is acknowledged but cannot be addressed in this assessment. Document will capture the thought.
6. E-series sensitivity runs – still not clear on how to make use of these. Clearly set out in SAR how to interpret results of scenarios.

Based on the summary points, discussion continued and the possibility of combining sensitivity runs was discussed. Participants felt that combining scenario A9 (recreational effort zero prior to 1950, ramping up exponentially to 2002, plus removal of salmon troll prior to 1950 and use ¼ of salmon troll catch values) and the removal of commercial CPUE, was the most realistic scenario.

There was then a lengthy discussion on how changing the reference case would lead to numerous changes in the document and decision tables. The participants were asked if they could accept the document without needing to see the revisions.

It was decided that all of the original runs would be kept and the proposed new run would be labelled as the "advice case". The document will provide an explanation of why particular data were not used. It was also agreed that it would not be necessary to redo all the sensitivity runs to compare to the advice case.

Questions came up on the conclusions of the E-series sensitivity runs (different ratios of $B_{MSY}/K$) and a participant was not sure that consensus was reached. He pointed out that it affects the perception of the fishery.

The authors explained that the value of $\varphi = B_{MSY}/K = 0.5$ is what is used in the reference case model and other values were explored in the E-runs, using a generalized surplus production model (McAllister et al. 1999) where the value of $\varphi$ can be set at any value between 0 and 1. The Schaefer model is the most commonly used (where $\varphi = 0.5$) and there was no rationale to use another model. No other rockfish species have used a non-Schaefer model when employing a surplus production model. The authors noted that the Schaefer model has been simulation tested elsewhere. In the absence of specific testing on Yelloweye Rockfish the authors were advised to provide some references on simulation testing.

An industry participant asked if the model was at fault and whether another type of model such as age-structured would be better. A science participant responded that if the authors had the data they would have used catch-at-age but they could not get there with the available data. In the future, there may be other approaches like spatial assessment methodologies.

It was requested that the authors add references to simulation testing and provide more discussion on figure 27 in the working paper.

### ADVICE RUN

There was consensus that the suggested new "advice run" would form the advice to management. Management participants requested that the decision tables display catch policies up to 300 t. The decision table for the advice run would be presented in the SAR.

## CONCLUSIONS

### CONSENSUS ON PAPER ACCEPTABILITY

The working paper was accepted. Required revisions are outlined in the following sections.

### CONSENSUS ON OUTSIDE YELLOWEYE ROCKFISH ASSESSMENT

This assessment suggests that the stock has continued to decline, despite more than a decade of rockfish conservation measures. Concerns about the inputs to the model were discussed and despite the limitations, there was consensus to adopt the BSP model to represent the Outside Yelloweye Rockfish population and to provide advice to managers.

### INSTRUCTIONS TO AUTHORS

- Expand the introduction to the stock assessment model with a few sentences outlining the modelling approach and also provide more explanation about differences between the Bayesian surplus production model and the application of the Delay Difference model to evaluate uncertainties.
- Elaborate on how historic catch data are derived and used in the main document, similar to that in Appendix A but in less detail.
- Highlight the need for habitat mapping and promote it in the document as a research need.
- Highlight visual ROV surveys as a research need.
- Provide more explanation on the role of RCAs in the assessment.
- Expand the information on genetic microsatellite work.
- Add references to simulation testing of the Schaefer model.
- Edit caption for Appendix Table A11 to denote that catches are derived for the model for salmon troll and recreational fisheries, and are not official landings.
- Fix typographical errors throughout the document, e.g., priors for K – fix typos p. 28 and Figure 21.

## RECOMMENDATIONS & ADVICE

- Sensitivity analyses considered six different sources of uncertainty: assumptions about the historic catch, priors for the intrinsic rate of increase and carrying capacity, process error standard deviation, various abundance indices, form of the surplus production function, and the form of the stock assessment model.
- The biomass in 2014 ($B_{2014}$) is estimated at 3,821 t (90% credibility interval of 2,428 – 7,138 t), which is 18% (90% credibility interval 10 – 33 %) of the estimated initial biomass ($B_{1918}$) of 21,955 t (90% credibility interval 13,747 – 37,694 t) in 1918.
- Fisheries reference points consistent with DFO's Precautionary Reference Points are presented for this assessment. There is a 63% probability that stock biomass in 2014 is below the Limit Reference Point (LRP) of $0.4B_{MSY}$ and a 99% probability that it is below the Upper Stock Reference (USR) of $0.8B_{MSY}$.
- Advice to management is presented in the form of decision tables, using 5, 10, and 15 year projections, for constant catch policies between 0 and 300 t/year. Replacement yield or surplus production in 2014 is estimated at 162 t (90% credibility interval 80 – 258 t). The current catch of 287 t in 2014 is estimated at 178% (90% credibility interval 114 – 360%) of replacement yield.
- This assessment suggests that the stock has continued to decline, despite more than a decade of rockfish conservation measures. Increases in Yelloweye Rockfish density have not yet been seen in Rockfish Conservation Areas, but given the low productivity of this species, benefits are not expected to be detected until at least 10 years after their closure.
- With the exception of the commercial groundfish fishery since 2006, the reconstruction of the commercial catch is a source of uncertainty in this assessment. This uncertainty can be attributed to a lack of species identification in landings, and inconsistent regional catch monitoring and catch data reporting. There is uncertainty in the commercial groundfish (pre-2006) and Pacific Salmon troll, recreational, and Aboriginal catches throughout these catch time series. Sensitivity tests to address uncertainties in catch were conducted.
- This assessment considers a single Outside stock based on genetic analyses. Further exploration of more spatially explicit harvest advice is recommended to assist with the management of the fisheries given
    i. the sedentary nature of Yelloweye Rockfish,
    ii. current spatial management, which includes conservation areas where direct commercial and recreational fishing is prohibited, and
    iii. area-based individual transferable quotas in the commercial groundfish fisheries.

## ACKNOWLEDGEMENTS

The Chair thanks the reviewers, Kray van Kirk, Dan Tonnes and Sean Cox, for their thorough reviews, as well as all the participants for their involvement, and Dana Haggarty for taking on the task of rapporteur. The assistance of the CSAP office in providing support for the meeting is greatly appreciated.

## REFERENCES

McAllister, M.K., Babcock, E.A., Pikitch, E.K., and Prager, M.H. 1999. Application of a non-equilibrium generalized production model to South and North Atlantic Swordfish: combining Bayesian and demographic methods for parameter estimation. ICCAT Col. Vol. Sci. Papers. SCRS/99/85.

## APPENDIX A: TERMS OF REFERENCE

### Stock Assessment for the outside population of Yelloweye Rockfish (*Sebastes ruberrimus*) in British Columbia in 2014

### Regional Peer Review – Pacific Region

**September 15-16, and 24, 2015**
**Nanaimo, British Columbia**

Chair: Kate Rutherford

### Context

Yelloweye Rockfish is a significant species within the rockfish hook and line, halibut, lingcod, and dogfish commercial fisheries, recreational fisheries, and First Nations Food, Social and Ceremonial (FSC) fisheries.

In 2006, the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) requested and received from Fisheries and Oceans Canada (DFO) a report summarizing the biology, life history, catch history and trends in Yelloweye Rockfish abundance. In November 2008, COSEWIC reviewed this report and designated the Yelloweye Rockfish (both the "inside" and "outside" populations) as a Species of Special Concern. Both populations of Yelloweye Rockfish have also been listed as a Species of Special Concern under the *Species at Risk Act*. The coastwide population of Yelloweye Rockfish was last assessed by DFO Science in 2001. The inside population of Yelloweye Rockfish was most recently assessed in 2010.

Fisheries and Oceans Canada (DFO) continues to implement the *Sustainable Fisheries Framework* (SFF), which is a toolbox of existing and new policies for DFO and other interests to manage Canadian fisheries to conserve fish stocks and support sustainable fisheries. The SFF includes conservation and sustainable use policies such as the *Fishery Decision-making Framework Incorporating the Precautionary Approach* (PA) which requires reference points and stock status zones (Healthy, Cautious and Critical); harvest strategy and harvest decision rules; and the need to account for uncertainty and risk (DFO 2009). Additionally, DFO's Rockfish Conservation Strategy (RCS) is a system of management measures tailored to providing protection to rockfish, to alleviate further population declines. In support of the continued implementation of the SFF and the RCS to facilitate management of those fisheries where Yelloweye Rockfish catch occurs, Fisheries Management Branch has requested that Science assess the stock status of the outside population of Yelloweye Rockfish relative to reference points that are consistent with the DFO SFF. Updated harvest advice is required to determine if current harvest levels are sustainable and compliant with the PA.

### Objectives

Guided by the Sustainable Fisheries Framework, particularly the *Fishery Decision-making Framework Incorporating the Precautionary Approach*, regional peer review participants will assess the following working paper to provide advice on the specific objectives outlined below.

*K. L. Yamanaka, M. K. McAllister, M-P. Etienne, and A. Edwards. Stock Assessment for the outside population of Yelloweye Rockfish (Sebastes ruberrimus) in British Columbia, Canada for 2014. CSAP Working Paper 2013GRF007.*

1. Estimate reference points consistent with the DFO Precautionary Approach, specifically a Limit Reference Point, an Upper Stock Reference, a Target Reference Point, and a Removal Reference for the offshore population of Yelloweye Rockfish, using best available science.

2. Evaluate the current status of Yelloweye Rockfish relative to the recommended reference points from Objective 1.
3. Describe the sources of uncertainty related to the model (e.g. model parameter estimates, assumptions regarding catch, productivity, carrying capacity and population status) based on sensitivity analyses and, where possible, explore the assumptions about catch, productivity, and carrying capacity.
4. Using probalistic decision tables, evaluate the consequences of a range of constant catch harvest policies to projected biomass relative to the reference points and additional stock metrics including projected biomass relative to current biomass.
5. Recommend an appropriate interval for reassessment of the offshore population of Yelloweye Rockfish.

### Expected Publications

- CSAS Science Advisory Report
- CSAS Research Document
- CSAS Proceedings

### Participation

- DFO Science, Fisheries Management
- Aboriginal communities
- Province of British Columbia
- External reviewers
- Industry
- Non-governmental organizations and other scientists and stakeholders.

### References

DFO. 2009. A Fishery Decision-making Framework Incorporating the Precautionary Approach.

## APPENDIX B: WORKING PAPER REVIEWS

### REVIEWER 1 – KRAY VAN KIRK, ALASKA DEPARTMENT OF FISH AND GAME

The working paper did not contain a formal abstract, but it was assumed that such an abstract would be equivalent to the primary references (Stanley et al. 2009), conditional on updated data and methods. In that context, this working paper summarizes a well-documented and extensively-detailed stock assessment. The various elements of the stock assessment model and the data used are well explained, and the conclusory sections (3. REFERENCE POINTS [page 52] and 4. STOCK PROJECTIONS [page 53]) and the associated Decision Tables [22 and 23] are clearly defined and well-supported.

This reviewer's comments are minor.

#### Main Section

***Section 2.4 – page 24***

The introduction of the stock assessment model could benefit from a single paragraph of just a few sentences outlining the general model approach, and thereafter making clear distinctions between the deterministic surplus production model and the application of the delay difference model to evaluate uncertainties. While Stanley et al. (2009) was extremely informative and a necessary reference, a few additional sentences here might prevent the need to consult it except in the case of more detailed model / statistical analyses.

It was noted that the structure, information, and equations contained in Appendix G of Stanley et al. (2009) were intuitive and fundamentally informative regarding the methods of the current working paper. Although limits must be placed on the length of each successive stock assessment, it might be considered whether to include the equivalent of this Appendix in future working papers.

***Section 2.7.6 – page 35***

While perhaps overly detailed for the aims of this stock assessment, it would be very interesting to see a more detailed exposition of the problems and solutions that presented themselves during nonlinear optimization, which can be a common but insufficiently addressed problem with both Bayesian and frequentist stock assessment models. Expanding the limits (bounds) of a given parameter may allow optimization success but still without complete exploration of the parameter space (i.e. a truncated distribution in some form), while overly generous limits may prevent optimization (or convergence) in the case of uninformative data.

#### Appendix A: Fishery Dependent Data

***Page 4, Table A1 and following***

Why was gamma for the halibut fishery fixed to such low proportions relative to the calculated gamma values in Table A1? The correspondence from Chris Sporer (A.9: CORRESPONDENCE) dated June 12, 2015 discusses this issue, and legitimately points out the change in YE market value and the consequent increase in target and retention on the part of the halibut fleet in the 1997 – 2005 period, but the critique of gamma values as 'high' appears to lack significant statistical support or reasoning.

***Page 6: A.2.1: Groundfish Trawl Fishery***

What was the industry reason for not calculating release ratios? Simply that trawl catch (release) is unlikely to survive?

***Page 12, Table A.4, and Page 22, Table A.11***

Is there a discrepancy between the Yelloweye Rockfish caught (tonnes) in the commercial salmon troll as presented by these two tables? Table A.4 shows no YE retention from 1952 – 2000 in the salmon troll fishery, whereas Table A.11 shows significant retention in that fishery. Have I misunderstood these tables?

**Appendix C: Multinomial Exponential Analysis and Appendix H: IPHC Survey Data**

Were the abundance indices assessed for normality? Or does the MEM make such an assessment superfluous?

## REVIEWER 2 – DAN TONNES, PROTECTED RESOURCED DIVISION, NATIONAL MARINE FISHERIES SERVICE

1. *Is the purpose of the working paper clearly stated*?

   Yes

2. *Are the data and methods adequate to support the conclusions*?

   *Yes.*

3. *Are the data and methods explained in sufficient detail to properly evaluate the conclusions*?

Yes, though the discussion in the first paragraph in section 2.1.1.1 is confusing. It appears to say that present-day catch compositions are used to understand/quantify historic catch compositions. There are two issues here: 1) it should be clarified which specific fisheries are used (i.e. are present-day trawl fishery data used for past trawl fisheries?) and, 2) it should be acknowledged that using present-day catch compositions assumes that past compositions where the same. In the case of yelloweye rockfish, it is likely that they are less frequent than historically, thus potentially introducing an under-estimate of historic catches. I don't have a solution for this, but if my interpretation is correct, this should at least be mentioned in the SA.

4. *If the document presents advice to decision-makers, are the recommendations provided in a useable form, and does the advice reflect the uncertainty in the data, analysis or process?*

Generally yes. I suggest the inclusion of an executive summary that emphasizes a cogent discussion of the conclusions

5. *Can you suggest additional areas of research that are needed to improve our assessment abilities?*

The SA does a generally good job of discussion additional research, most importantly including the importance and promise of visual surveys. However, additional details on these studies should be added, and the data needs should be more explicitly identified.

**Additional Research that Should be Considered (Numbered but not Prioritized)**:

1. Efficacy of the outside RCAs in restoring (or not) biological attributes (namely productivity) of yelloweye rockfish should be assessed, with the goal of integrating these findings into future SA's. Implicit in this research item is understanding/monitoring the relative compliance with RCAs (see discussion of recreational fishery compliance in Haggarty 2013).

2. I am not up to date with the status of "outside" seafloor mapping, but this may be an important research item to better quantify yelloweye rockfish habitat - and would complement the efficacy of visual surveys.

3. Conducting genetic work on yelloweye rockfish to assist in understanding the effective population size (if possible) should be investigated.

4. As mentioned, additional data regarding age-structure should be collected. This data could be augmented through cooperative programs with various fishing sectors. Similarly, research should be conducted to determine the fraction of bycaught yelloweye rockfish that are released with descending devices, and updated mortality estimates could be used in future SA's. See GMT (2014).

**References**

Groundfish Management Team. 2014 (March). Supplemental GMT Report 2. Groundfish management team report on proposed discard mortality for cowcod, canary rockfish, and yelloweye rockfish released using descending devices in the recreational fishery.

Haggarty, D. 2013. Rockfish conservation areas in B.C: Our current state of knowledge. Prepared for the David Suzuki Foundation and Gordon and Betty Moore Foundation.

## REVIEWER 3 – SEAN COX, SIMON FRASER UNIVERSITY

**General Comments**

First, I appreciate all the effort that went into this assessment despite the difficulty of the situation. Being asked to estimate reference points and biomass for Yelloweye Rockfish (YE) in B.C. immediately corners assessment scientists into fitting some kind of model to whatever data are available – and the data for YE are particularly sparse, imprecise, and probably biased. The catch history prior to the 1980s is hugely uncertain and almost surely not what appears in this paper as a catch series. Fishery-dependent CPUE was declared unusable more than a decade ago, not because of poor catch monitoring and reporting, but because Yelloweye and other inshore rockfish species were serially depleted – that is, fishermen were able to maintain high CPUE by moving to new habitat when local rockfish populations were depleted. Fishery CPUE would, therefore, not be linearly proportional to YE abundance. This problem cannot be rectified by simply splitting data series by management era or by improving catch monitoring, although the latter could help quite a bit in a spatially-explicit stock assessment context or in designing spatial approaches to reducing YE catch in the future.

There is only one fishery-independent survey (PHMA) actually designed to index inshore rockfish abundance, but that survey is far too short and lacks sufficient contrast at this time to provide the information required for estimating biological reference points. Although the IPHC survey for Halibut is longer, it is not actually designed to index rockfish and therefore catches very few of them (only about 38% of sets caught YE, and the sets that do, only catch a few). The first few years of this survey (1995-1997) are not even used to index Halibut by the IPHC, yet those data points are included here for YE. I assume this is because, without 1995-97 points, the YE abundance trend in the survey gets substantially weaker. The remaining fishery-independent data are even worse. For instance, only 2-15% of trawl survey sets catch YE rockfish, and the numbers-caught-per-set are very low (e.g., 2-6) when they do occur. Some surveys index numbers of rockfish, others index biomass, and most only represent a small fraction of total YE habitat. Combined, these issues mean that none of the observation error variances can be estimated; instead, they need to be fixed at values more reflective of well-designed, stock-specific surveys.

So, a model-fitting exercise based on inadequate data forces the analysts into the construction business; that is, construction of catch series, construction of abundance data series, construction of prior distributions for model parameters, construction of multiple models and decision tables. Needless to say, a model fitted to this kind of information really represents one of many possible scenarios for the stock history, biological reference points, and current status. These scenarios are a strong reflection of the assumptions underlying all the choices made in the various construction processes (and there are many of these as discussed below in the Specific Comments section).

If the point of this assessment is to check the PA policy box that says, "yes, we have biological reference points and have included uncertainty in biomass projections under different TACs", then it has accomplished its purpose. However, this is a short-term solution to a complex, long-term problem that will be around for a long time into the future. YE are just one of many species in this situation, so it seems timely to recommend that science, managers, stakeholders, and First Nations begin working together on new assessment and/or management approaches that go beyond simply fitting models to data and, instead, propose realistic solutions to these kinds of weak-stock problems.

**Additional topics that should be discussed in the paper**

1. In general, there is not enough discussion about the limitations underlying this assessment. For example, I didn't see any discussion of spatial population structure implications. It is reasonably well-documented in the scientific literature, as well as in previous YE assessments, that YE rockfish are more spatially structured than typical groundfish (e.g., halibut, sablefish, etc) and there is little movement/mixing among sub-populations. Assuming a coastwide, aggregate population in the BSP seems pretty unrealistic unless sub-populations are all dynamically similar (i.e., similar productivity and carry capacity) and catch is uniformly distributed.
2. The whole RCA program was established based on the scientific understanding that YE are spatially-structured. So, how do RCAs fit into this assessment? They are mentioned at the beginning as leading to a 50% reduction in fishing mortality, yet none of the subsequent analyses, models, etc. even mention them.
    a. Have the catches and abundance indices since 2002 or so come from outside RCAs and therefore only 50% of YE habitat? Doesn't this mean that 50% of biomass was removed from the BSP model biomass? This implies that YE outside RCAs have higher F than estimated by the model.
    b. Are the projections only representing the 50% of biomass outside RCAs?
    c. How should a manager take RCAs into account in interpreting the reference points, status, and projections?
3. What are the implications of fitting a biomass dynamics model to count data (i.e., population numbers) for a stock that is probably far from equilibrium and having changes in average weight (and possibly also changes in weight-at-age)?
4. It is likely that some of these surveys have dome-shaped selectivity for YE. Trawls, in particular, often show domed selectivity patterns.
5. The Decision Tables could benefit from more explanation. How is a manager supposed to use these? According to the text, Bayes Factors ranging from 0.12 to 2.2 would be considered unimportant, so the manager is given a set of equally plausible hypotheses - which Table and Column should a manager choose?

6. Research Needs: I don't think the catch series will ever be resolved and agreed – how could that possibly happen now given massive changes in fleet composition (and people)? I don't think anyone would disagree that the stock is probably severely depleted, regardless of the observed historical catch series. The more critical research question is: how can groundfish, recreational, and First Nations fisheries move forward without causing further problems? That seems like a tactical issue for which the data we do have could actually help - e.g., geo-referenced commercial catch, PHMA surveys, visual surveys, IPHC. There must be some creative ways to steer fisheries away from YE populations by some combination of technology and proper incentives.
7. Research: this is not necessarily a "need", but a question. Halibut have been through a major depletion and recovery over the past 100+ years. Have historical declines in halibut abundance possibly helped YE persist despite long-term chronic over-fishing?
8. There is no advice about future assessment intervals as requested in the TOR.

**Additional analyses that I think are needed.**

1. Fit the BSP model using only the PHMA and IPHC 1998-2014 surveys – this is similar to Sensitivity Analysis D.4, but with the IPHC modified. I am interested to see what the process errors do in the mid-1990s, since they seem to account for a 2-5% decline per year during that time when fitting includes the 1995-1998 data.
2. Same as (1), but with observation error variances estimated and process error set equal to 0. There should be some kind of null model that reflects the real information content of the data.
3. A power analysis is needed to determine whether "the nominal [IPHC] survey series from 1995 to 2014 (except 2013) has shown to reflect abundance trends over the entire BC coast" (page 13). This statement is made based on a visual inspection alone of IPHC data from north of V.I. vs. north of V.I. + WCVI stations. However, the north stations represent 80% of the total, so it is more likely that the nominal series is unaffected by addition of the WCVI stations. That doesn't imply that north and south are doing the same thing and can be treated as one. This is particularly important to understand, because managers will need to divide up the TAC among management areas there does not seem to be a lot of wiggle room for spatial mismatches in TACs and biomass.
4. How does the PMPD model fit the data?
5. The posterior summaries should include a post/prior variance ratio. In some cases, the shifting in position of the posterior relative to the prior could just be caused by parameter correlations. The above ratio would help show the actual change of information content by including the data.

**Catch**

Why is the catch reconstructed back to 1918? There is no information from that time and the catch is probably terribly biased. For instance, the catch data indicate that the halibut fishery only caught 0.3-18 tonnes of Yelloweye between 1918 and 1940. In the early part of this period, most of the Halibut catch (for all the Pacific) was taken from Area 2B and it drove the halibut stock very low by the 1940s. Maybe we could learn something about Yelloweye avoidance from those guys.

The attempt to model fishing mortality as the product of effort and a 2%/yr increase in catchability doesn't recognize the abrupt changes that occurred in this fishery, like changes to circle hooks that doubled catch rates over 1-2 years in the 1980s.

Similar arguments apply to things like the troll catch – currently, this fishery appears to take 50-250 Yelloweye per year (coastwide) and these numbers are used to extrapolate back to times when troll effort was an order of magnitude higher. Again, assuming constant troll catchability over a very long time frame seems unrealistic.

**Fishery indices**

Even the IPHC doesn't use the 1995-1997 catch rates from the standardized survey, yet they are used here. The design was different in that time and the design was "completely changed" for 1998 and beyond for several reasons documented in IPHC Tech Report 0058. There should be a sensitivity analysis using only IPHC (1998-2014) and PHMA; those would be the only credible data sets, despite low occurrence and catch rates in IPHC survey.

The claim that the IPHC northern stations reflect coastwide abundance is unsubstantiated without a proper power analysis. The northern region represents 80% of the stations and catch rates are higher. So, combining data from north and south just shows that the north dominates the overall survey pattern, not that it reflects coastwide abundance. Catch rates in the south are, in fact, lower and generally decreasing more than the north. So, the consequences of using only north is to lose whatever trend is happening in the south.

The tables (e.g., A.12) of index values should show the actual units of the indices, which are mostly not tonnes.

Chopping fishery-dependent datasets into short pieces eliminates any value, so they should be dropped. They could all be thrown out just by imagining the many reasons why they are probably not linearly related to coastwide abundance...or by checking assessments for YE rockfish from late 90s or so.

**The models**

***Bayesian surplus production***

The modeling seems more like a simulation than estimation. The data are mostly uninformative in their raw state, which means the variance parameters need to be fixed and assumed known at relatively precise values even though there is only 1 survey (PHMA) actually designed to index inshore rockfish. If the observation error terms were estimated, I suspect they would all be large and the model parameter estimates would be totally dependent on the priors.

What are the implications of fitting a biomass dynamics model to count data for a stock that is probably far from equilibrium and possibly having changes in average weight?

The explanation of "Proc sigma", "Obs sigma", $\sigma_p$ is confusing. "Proc sigma" is explained as a process error between modeled and observed abundances; however, that use of "process error" is not consistent with state-space modelling definitions where process errors specifically affect the future system state. I think a better definition would be "design error" meaning that there are systematic differences among years caused by the fixed station design that are not reflected in the sampling errors computed from the raw data (i.e., observation errors based on "Obs sigma").

***Bayesian delay-difference***

I didn't find any value in the delay-difference model or the way it was presented. The model, as well as simulation tests, are not completely documented or sufficiently explained. For instance, there is no presentation of the likelihood functions or joint posterior density function. There are also some unconventional practices like using a scaling constant to fit observed and predicted mean weight data. Predicted mean weight is just Bt/Nt, so scaling can only be a units change

from, say tonnes (Bt) to kg (mean individual weight) or perhaps to reflect characteristics of the fish used to measure observed mean weight. Were the headed and gutted, previously frozen? I could not understand the purpose of fitting to B0 in E.17 since the delay-difference model reproduces age-structured dynamics (and equilibria) exactly when growth follows the vonB (even parameterized via Ford-Walford approach).

The simulation-estimation (Figure 27) comparing the BDD and BSP models raises some serious doubts about the reliability of the BSP model. For example, while the real stock is declining, the over-estimation bias increases from about 8% when the stock is large and declining slowly, but reaches about 35% just before the collapse in the 1990s. I don't see how the text in the paper can say this is "slightly biased". Yes, when the stock is at the bottom of the collapse, near 10% of B0, the BSP is slightly positively biased – any model would pick that up, but at the critical time it was pretty severe. It seems like a dangerous model to use for setting TACs, at least when biomass is changing relatively rapidly.

**Research needs**

Given the importance of YE to commercial, recreational, and First Nations fisheries, I expected a lot more from this research section. There is no real insight into a stock assessment or management path forward. Visual surveys were only done for a couple of years because they are prohibitively expensive. They are also subject to biases that are difficult to measure.

Age-structured modeling could be possible sometime in the future, but the age composition data cannot be interpreted as suggested in this section since they appear to be combined age samples across different surveys, and they are based on total sample sizes rather than proportions. I cannot see cohort progressions in that data.

It is likely that TACs for YE will need to be low for some time into the future. So, how can science help fisheries and managers minimize unnecessary catch while pursuing other fisheries? I think this is a more practical question for which we actually have a lot of good data.

## APPENDIX C: AGENDA

Canadian Science Advisory Secretariat

Centre for Science Advice Pacific

Regional Peer Review Meeting (RPR)

**Stock Assessment for the Outside Population of Yelloweye Rockfish (*Sebastes ruberrimus*) for British Columbia, Canada in 2014**

**September 15-16, and 24*, 2015**

Seminar Room A/B, Pacific Biological Station, Nanaimo, BC

Chair: Kate Rutherford

**DAY 1 Tuesday, September 15**

| Time | Subject | Presenter |
|---|---|---|
| 0900 | Introductions<br>Review Agenda & Housekeeping<br>CSAS Overview and Procedures | Chair |
| 0915 | Review Terms of Reference | Chair |
| 0930 | Presentation of Working Paper | Authors |
| 1030 | ***Break*** | |
| 1050 | Questions & Points of Clarification | RPR Participants |
| 12:00 | ***Lunch Break*** | |
| 1300 | Overview Written Reviews | Chair +<br>Reviewers & Authors |
| 1500 | ***Break*** | |
| 1515 | Identification of Key Issues for Group Discussion<br>Discussion & Resolution of Technical Issues<br>Discussion & Resolution of Results & Conclusions | RPR Participants |
| 1700 | Adjourn for the Day | |

**DAY 2 Wednesday, September 16**

| Time | Subject | Presenter |
|---|---|---|
| 0830 | Introductions<br>Review Agenda & Housekeeping<br>Review Status of Day 1 | Chair |
| 0845 | *(As Necessary)*<br>Carry forward outstanding issues from Day 1 | RPR Participants |
| 1000 | Develop Consensus on Paper Acceptability & Agreed-upon Revisions | RPR Participants |
| 1030 | ***Break*** | |
| 1050 | **Science Advisory Report (SAR)**<br>Develop consensus on the following for inclusion:<br>• Sources of Uncertainty<br>• Results & Conclusions<br>• Additional advice to Management (as warranted) | RPR Participants |
| 1200 | ***Lunch Break*** | |
| 1300 | **Science Advisory Report (SAR)**<br>• Continued | RPR Participants |
| 1445 | ***Break*** | |
| 1500 | Next Steps – Chair to review<br>• SAR review/approval process and timelines<br>• Research Document & Proceedings timelines<br>• Other follow-up or commitments (*as necessary)* | Chair |
| 1545 | Other Business arising from the review | Chair & Participants |
| 1600 | ***Adjourn meeting*** | |

*No agenda was provided for Day 3, September 24th.

## APPENDIX D: PARTICIPANTS

| Last Name | First Name | Affiliation |
|---|---|---|
| Acheson | Chris | Canadian Sablefish Association |
| Ackerman | Barry | DFO Fisheries Management Groundfish |
| Argue | Sandy | Province of BC |
| Ashcroft | Chuck | Sport Fishing Advisory Board (SFAB) |
| Binning | Kelly | DFO Fisheries Management |
| Boyes | Dave | Commercial Industry Caucus Halibut |
| Brown | Laura | DFO Science |
| Cox | Sean | SFU |
| Davis | Neil | DFO Fisheries Management Groundfish Management |
| Edwards | Andrew | Science, Groundfish Section |
| Forrest | Robyn | Science, Groundfish Section |
| Haggarty | Dana | DFO Science, Groundfish Section |
| Haigh | Rowan | DFO Science, Groundfish Section |
| Hargreaves | Marilyn | DFO Science, Centre for Science Advice Pacific |
| Keizer | Adam | DFO Fisheries Management Groundfish Management |
| King | Jackie | DFO Science, Groundfish Section |
| Kronlund | Rob | DFO Science, Groundfish Section |
| Lane | Jim | Nuu-chah-nulth Tribal Council |
| Leslie | Karen | DFO, Species at Risk Program |
| MacDougall | Lesley | DFO Science, Centre for Science Advice Pacific |
| McAllister | Murdoch | UBC |
| Mose | Brian | Commercial Industry Caucus Trawl |
| Nottingham | Melissa | DFO Science, Groundfish Section |
| Olsen | Norm | DFO Science Stock Assessment |
| Rutherford | Kate | DFO Science, Groundfish Section |
| Sporer | Chris | Pacific Halibut Management Association |
| Tadey | Rob | DFO Fisheries Management Groundfish |
| Tonnes | Dan | NMFS NOAA |
| Turris | Bruce | BC Groundfish Conservation Society |
| Van Kirk | Kray | Alaska State Fish and Game |
| Workman | Greg | DFO Science, Groundfish Section |
| Yamanaka | Lynne | DFO Science, Groundfish Section |

## APPENDIX E: ABSTRACT OF WORKING PAPER

A new stock assessment is presented for the Outside population of Yelloweye Rockfish (*Sebastes ruberrimus*) in British Columbia, Canada for 2014. This assessment considers a single Outside stock based on genetic analyses. A non-equilibrium, age-aggregated Bayesian surplus production (BSP) model was used in this assessment, employing catch data derived from historic commercial, recreational and Aboriginal catch records reconstructed back to 1918, life history data to estimate the intrinsic rate of increase (*r*), and abundance trends derived from research surveys and commercial hook and line catch records. Sensitivity analyses considered six different sources of uncertainty: assumptions about the historic catch, priors for the intrinsic rate of increase and carrying capacity, the amount of process error standard deviation, the accuracy in different abundance indices, the form of the surplus production function, and the form of the stock assessment model.

The BSP model fits the stock trend data well and predicts a steep stock decline in the mid-1980s to the mid-1990's, coincident with a substantial increase in fishery catches and also the more gradual decline seen in most of the indices since then. Management advice is based on output from a reference or base case BSP model run which estimates that the Outside Yelloweye Rockfish biomass in 2014 ($B_{2014}$) is at 3,821 t (90% credibility interval of 2,428 – 7,138 t), which is 18% (90% credibility interval 10 – 33 %) of the estimated initial biomass in 1918 ($B_{1918}$) of 21,955 t (90% credibility interval 13,747 – 37,694 t). Fisheries reference points consistent with DFO's Precautionary Reference Points are presented for this assessment. There is a 63% probability that $B_{2014}$ is below the Limit Reference Point (LRP) of 0.4 $B_{MSY}$ and a 99% probability that it is below the Upper Stock Reference (USR) of 0.8 $B_{MSY}$.

Advice to management is presented in the form of decision tables, using 5, 10, and 15 year projections, for constant catch policies between 0 and 300 t/year. Replacement yield or surplus production in 2014 is estimated at 162 t (90% credibility interval 80 – 258 t). The current catch of 287 t in 2014 is estimated at 178% (90% credibility interval 114 – 360%) of replacement yield.

This assessment suggests that the stock has continued to decline since the mid-1990's, despite reductions in fishing mortality and in 2002, extensive rockfish conservation measures. Increases in Yelloweye Rockfish density were not apparent between 2009 and 2011 in Rockfish Conservation Areas, but given the low productivity of this species, benefits are not expected to be detected until at least 10 years after their closure.

With the exception of the commercial groundfish fishery since 2006, the reconstruction of the commercial catch is a source of uncertainty in this assessment. This uncertainty can be attributed to a lack of species identification in landings, and inconsistent regional catch monitoring and catch data reporting. There is uncertainty in the commercial groundfish (pre-2006) and Pacific Salmon troll, recreational, and Aboriginal catches throughout these catch time series. Sensitivity tests to address uncertainties in catch were conducted.

Further exploration of more spatially explicit harvest advice is recommended to assist with the management of the fisheries in light of the sedentary habit of Yelloweye Rockfish, current spatial management which includes conservation areas where direct commercial and recreational fishing is prohibited, and area-based individual transferable quotas in the commercial groundfish fisheries.